New Hampshire Volunteer Lake Assessment Program

2002 Bi-Annual Report for
Mine Falls Pond (Mill Pond)
Nashua

NHDES
Water Division
Watershed Management Bureau
6 Hazen Drive
Concord, NH 03301

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

2002

OBSERVATIONS & RECOMMENDATIONS

Welcome back to the New Hampshire Volunteer Lake Assessment Program (VLAP)! As your association continues to participate in VLAP over the years, the database created for your lake/pond will help your association track water quality trends and will ultimately enable the association and DES to identify potential sources of pollutants from the watershed that may affect water quality.

The sampling conducted at Mill Pond this season is part of the **Mill Pond Restoration Project – Phase II**, which is being conducted by the Nashua Regional Planning Commission. A water quality monitoring program was established this season with assistance from the New Hampshire Department of Environmental Services' Volunteer Lake Assessment Program, Mine Falls Park Advisory Committee, and the Nashua Regional Planning Commission. Five monthly (June – October) sample events were conducted in the pond, and wet weather sampling was conducted at the stormwater outfalls to the pond during five storm events.

We understand that future sampling will depend upon volunteer availability, and the commission's water monitoring goals and funding availability. We would like to point out that **water quality trend analysis is not feasible with only a few data points.** It will take many years to develop a statistically sound set of water quality baseline data. Specifically, after 10 consecutive years of participation in the program, we will be able to analyze the in-lake data with a simple statistical test to determine if there has been a significant change in the annual mean chlorophyll-a concentration, Secchi-disk transparency reading, and phosphorus concentration. Therefore, frequent and consistent sampling will ensure useful data for future analyses.

After reviewing data collected from **MILL POND (also known as MINE FALLS POND),** the program coordinators recommend the following actions.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake/pond has been monitored through the program.

Chlorophyll-a, a pigment naturally found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the concentration of algae or lake productivity. The mean (average) summer chlorophyll-a concentration for New Hamsphire's lakes and ponds is 7.02 ug/L.

Similar to the summer of 2001, the summer of 2002 was filled with many warm and sunny days and there was a lower than normal amount of rainfall during the latter-half of the summer. The combination of these factors resulted in relatively warm surface waters throughout the state. The lack of fresh water to the lakes/ponds reduced the rate of flushing which may have resulted in water stagnation. Due to these conditions, many lakes and ponds experienced increased algae growth, including filamentous green algae (the billowy clouds of green algae typically seen floating near shore), and some lakes/ponds experienced nuisance cyanobacteria (blue-green algae) blooms.

The current year data (the top graph) show that the chlorophyll-a concentration ***increased slightly*** from June to July, ***increased greatly*** from July to August, ***decreased greatly*** from August to September, and then ***increased slightly*** from September to October. The chlorophyll-a concentration in August (55 mg/m^3) ***greatly exceeded*** the state mean, which suggests that a major algal bloom occurred in the pond on this sampling date. However, the transparency reading on the August sampling date was not severely reduced, as one would expect during a major algal bloom. It is possible that the elevated chlorophyll concentration in August was due to sampling or laboratory error.

The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is ***much greater than*** the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows ***an increasing*** in-lake chlorophyll-a trend, meaning that the concentration has ***worsened*** since monitoring began in 2000. However, please keep in mind that this trend is based on only two sampling seasons.

After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historic data to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcomed. In freshwater lakes/ponds, phosphorus is the nutrient that algae depend upon for growth. Therefore, algal concentrations may increase with an increase in nonpoint sources of nutrient loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). It is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality.

- **Figure 2 and Table 3:** The graphs in Figure 2 (Appendix A) show historical and current year data for lake/pond transparency. Table 8 lists the maximum, minimum and mean transparency data for each sampling season that the lake/pond has been monitored through the program.

  Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. The mean (average) summer transparency for New Hampshire's lakes and ponds is 3.7 meters.

  Two different weather related patterns occurred this past spring and summer that influenced lake quality during the summer season.

  In late May and early June of 2002, numerous rainstorms occurred. Stormwater runoff associated with these rainstorms may have increased phosphorus loading, and the amount of soil particles washed into waterbodies throughout the state. Some lakes and ponds experienced lower than typical transparency readings during late May and early June.

  However, similar to the 2001 sampling season, the lower than average amount of rainfall and the warmer temperatures during the latter-half of the summer resulted in a few lakes/ponds reporting their best-ever Secchi-disk readings in July and August (a time when we often observe reduced clarity due to increased algal growth)!

  The current year data (the top graph) show that the in-lake transparency ***decreased slightly*** from June to July, ***increased*** from July to September, and then ***decreased from*** September to October.

  Overall, visual inspection of the historical data trend line (the bottom graph) shows ***a stable*** trend for in-lake transparency, meaning that the transparency has ***remained approximately the same*** since monitoring began. Again, please remember that this trend is based on a limited data set.

As discussed previously, after 10 consecutive years of sample collection, we will conduct a statistical analysis of the historic data to determine long-term trends in lake quality.

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from NHDES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amounts of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake/pond has joined the program.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake/pond can lead to increases in plant and algal growth over time. The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.

  The current year data for the epilimnion (the top inset graph) show that the total phosphorus concentration ***decreased greatly*** from June to August, and then ***increased gradually*** from August to October. The total phosphorus concentration on each sampling event was ***greater than*** the state median, and was ***greatly exceeded*** the state median in June and July.

  The historical data show that the 2002 mean epiliminetic total phosphorus concentration is ***approximately two and a half times greater than*** the state median.

  The current year data for the hypolimnion (the bottom inset graph) show that the total phosphorus concentration ***decreased greatly*** from June to July, ***increased*** from July to August, and then ***decreased*** from August to October. The total phosphorus concentration on each sampling event was ***greater than*** the state median, and was ***greatly exceeded*** the state median in June and August.

The historical data show that the 2002 mean hypolimnetic total phosphorus concentration is ***approximately five times greater than*** the state median.

Overall, visual inspection of the historical epilimnetic data trend line shows ***a slightly increasing*** total phosphorus trend, which means that the concentration has ***slightly worsened*** in the epilimnion since monitoring began.

Overall, visual inspection of the historical data trend line for the hypolimnion shows ***a stable*** total phosphorus trend, which means that the concentration has ***remained approximately the same*** in the hypolimnion since monitoring began.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within an urban pond's watershed lake or pond's watershed typically include stormwater runoff from parking lots and roadways.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**

  Table 2 lists the current and historic phytoplankton species observed in the lake/pond. The dominant phytoplankton species observed this year were ***Asterionella*** **(a diatom), and** ***Ceratium*** **(a dinoflagellate).**

  Phytoplankton populations undergo a natural succession during the growing season (Please refer to page 12 of the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds. An overabundance of cyanobacteria (previously referred to as blue-green algae) indicates that there may be an excessive total phosphorus concentration in the lake/pond, or that the ecology is out of balance. Some species of cyanobacteria can be toxic to livestock, pets, wildlife, and humans. (Please refer to pages 12 - 14 of the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

- **Table 4: pH**

  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 5.5 severely limits the growth and reproduction of fish. A pH between 6.5 and 7.0 is ideal for fish. The mean pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is 6.5, which indicates that the surface waters in state are slightly acidic. For a more detailed explanation regarding pH, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The mean pH at the deep spot this season ranged from **6.60** in the hypolimnion to **7.06** in the epilimnion, which means that the pH of the water column ranged from ***slightly acidic*** **to** ***neutral*** **(meaning no acidity).**

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH. There are some environmental and political solutions available to minimize this problem, however, there is not a cost effective restoration management technique that can be implemented.

- **Table 5: Acid Neutralizing Capacity**

Table 5 in Appendix B presents the current year and historic epilimnetic ANC for each year the lake/pond has been monitored through VLAP.

Buffering capacity or ANC describes the ability of a solution to resist changes in pH by neutralizing the acidic input to the lake. For a more detailed explanation, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper much greater than the state mean of 6.7 mg/L (Table 5). Specifically, this indicates that **MINE FALLS POND** is "***not vulnerable***" to acidic inputs (such as acid precipitation) and has a greater ability than most lakes and ponds in the state to buffer against acidic inputs. While this may seem like a positive condition in the pond, the high ANC is likely due to higher concentrations of ions such as phosphorus, calcium, and metals from watershed runoff into the pond.

- **Table 6: Conductivity**

Table 6 in Appendix B presents the current and historic conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current. For a more detailed explanation, please refer to page 16 of the "Chemical Monitoring Parameters" section of this report.

The in-lake conductivity has been ***very high*** in the lake/pond since monitoring began (ranging from 369 to 628 uMhos/cm). Typically conductivity levels greater than 100 uMhos/cm indicate the influence of human activities on surface water quality. These activities include septic system leachate, agricultural runoff, iron deposits, and road runoff (which contains road salt during the spring snow melt).

However, the conductivity level for the majority of the stormwater outfall samples collected this season was ***relatively low.*** It is important to note that conductivity is directly related to the total **dissolved** (in solution, not in particulate form) **inorganic** chemicals (meaning chemical substances of mineral origin, not of basically carbon compounds) in the water. **Therefore, the stormwater data for this season shows a relatively small amount of dissolved inorganic chemicals, such as chloride or metals, in the stormwater outfalls.** This is "good" with respect to water quality, however, it is surprising given the proximity of roadways and parking lots in the immediate watershed.

It is possible that the "first flush" (the stormwater containing the high initial pollutant load) was not captured during the wet weather sampling events. (Please refer to this year's "Special Topic Article" which is included in Appendix D of this report, for a more detailed explanation regarding "first flush".) Also, since chlorides have a tendency to be tied up in the soils and/or quickly travel through the soils to the groundwater, it is possible that a portion of the chlorides never reached it to the surface water that was sampled during the stormwater sampling events.

- **Table 8: Total Phosphorus**

Table 8 in Appendix B presents the current year and historic total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to page 17 of the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was ***very high*** in the majority of the stormwater outfall samples that were collected this season. In addition, most of the stormwater samples were high in turbidity and were gray colored. These data and observations, combined with the low conductivity levels, suggest that most of the phosphorus in the stormwater runoff is **organic** (plant and animal residues, or substances made by living organisms, based upon carbon compounds) **particulate** (meaning not dissolved) phosphorus which is attached to **aluminum silicates** (clay particles) from soil erosion which is occurring in the watershed. However, the only way to be sure that this is the case is to test the stormwater runoff for **orthophosphate** (inorganic phosphate). If the commission is interested in sampling for orthophosphate, please contact the VLAP Coordinator or Limnology Center director for instructions.

In addition, the atmospheric deposition of particulate matter could be contributing to the elevated phosphorus and turbidity levels in the stormwater runoff. Typically, the burning of fossil fuels (coal, oil, and gas) releases particulate matter (ash, soot) which contains phosphorus into the atmosphere. Particulate matter settles on to the surfaces of rooftops, roadways, and parking lots and is eventually washed into surface waters during stormevents.

We recommend that your monitoring group conduct stream surveys and additional stormwater sampling along the inlets so that we can more accurately pinpoint the sources that may be causing the elevated concentrations.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**

  Table 9 in Appendix B shows the dissolved oxygen/temperature profile(s) for the 2002 sampling season. Table 10 shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***low in the hypolimnion*** at the deep spot of the lake/pond. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses. In addition, as lakes/ponds age, oxygen becomes ***depleted*** in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment.

  In addition, during this season, and during the 2002 sampling season, the lake/pond had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of ***internal total phosphorus loading*** (commonly referred to as ***internal loading***) is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column.

  The ***low*** oxygen level in the hypolimnion is a sign of the lake's/pond's ***aging*** and ***declining*** health. This year the DES biologist conducted the temperature/dissolved oxygen profile in ***June.*** We recommend that the annual biologist visit for the 2003 sampling season be scheduled during ***July or August*** so that we can determine if the oxygen depletion becomes more severe in the hypolimnion as the summer progresses.

- **Table 11: Turbidity**
  Table 11 in Appendix B lists the current year and historic data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to page 19 of the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  As discussed previously, the majority of the stormwater outfall samples were high in turbidity and gray in color. These data and observations suggest erosion of soils in the watershed is producing stormwater runoff high in aluminum silicates (clay particles). is occurring in the watershed and causing aluminum silicates (clay particles) to be present in high amounts in stormwater runoff. We recommend that your monitoring group conduct stream surveys and additional stormwater sampling along the inlets so that we can more accurately pinpoint the sources that may be causing the elevated levels.

DATA QUALITY ASSURANCE AND CONTROL

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

NOTES

- **Biologist's Note (6/20/02):** Much of the surface of the pond is covered with algal masses.

- **Monitor's Note (10/10/02):** Algae has submerged since last sampling date.

USEFUL RESOURCES

Changes to the Comprehensive Shoreland Protection Act: 2001 Legislative Session, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/sp/sp-8.htm

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet, (603) 271-3505, or www.des.state.nh.us/factsheets/wmb/wmb-10.htm

The Lake Pocket Book. Prepared by The Terrene Institute, 2000. (internet: www.terrene.org, phone 800-726-4853)

Managing Lakes and Reservoirs, Third Edition, 2001. Prepared by the North American Lake Management Society (NALMS) and the Terrene Institute in cooperation with the U.S. Environmental Protection Agency. Copies are available from NALMS (internet: www.nalms.org, phone 608-233-2836), and the Terrene Institute (internet: www.terrene.org, phone 800-726-4853)

Organizing Lake Users: A Practical Guide. Written by Gretchen Flock, Judith Taggart, and Harvey Olem. Copies are available form the Terrene Institute (internet: www.terrene.org, phone 800-726-4853)

Proper Lawn Care in the Protected Shoreland: The Comprehensive Shoreland Protection Act, WD-SP-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/sp/sp-2.htm

Sand Dumping - Beach Construction, WD-BB-15, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-15.htm

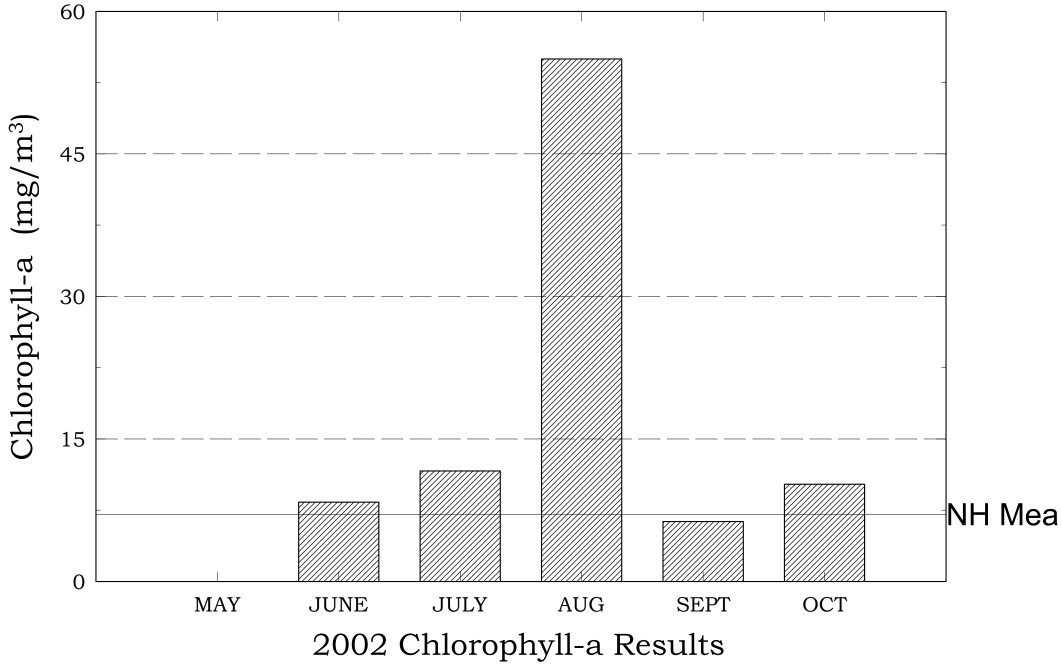
Swimmers Itch, WD-BB-2, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/bb/bb-2.htm

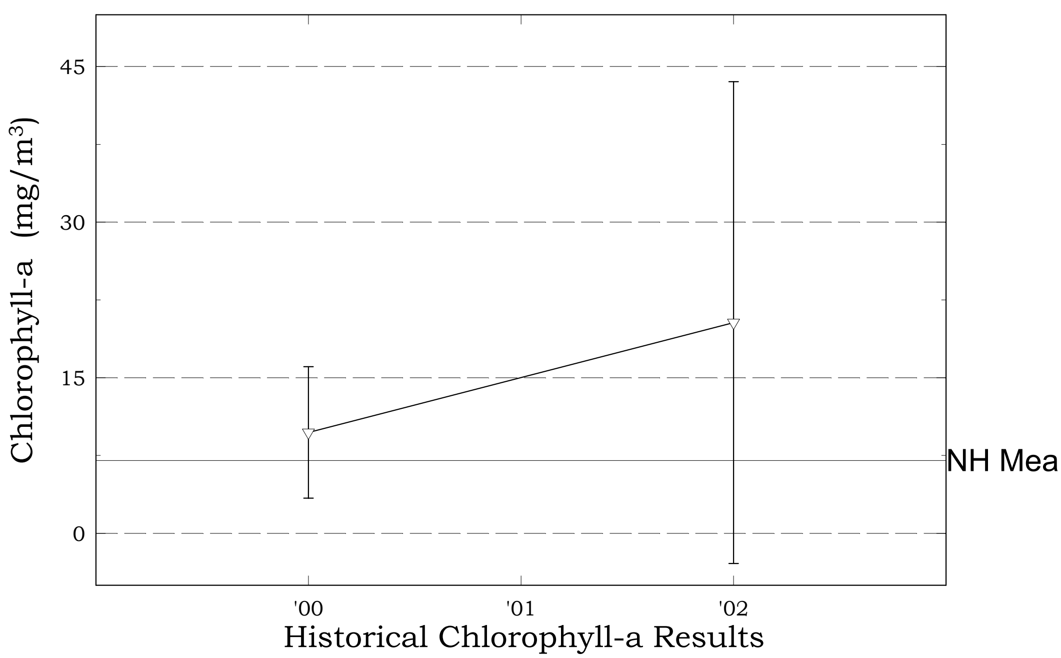
Use of Lakes or Streams for Domestic Water Supply, WD-WSEB-1-11, NHDES Fact Sheet, (603) 271-3503 or www.des.state.nh.us/factsheets/ws/ws-1-11.htm

Appendix A: Graphs

Mine Falls Pond, Nashua

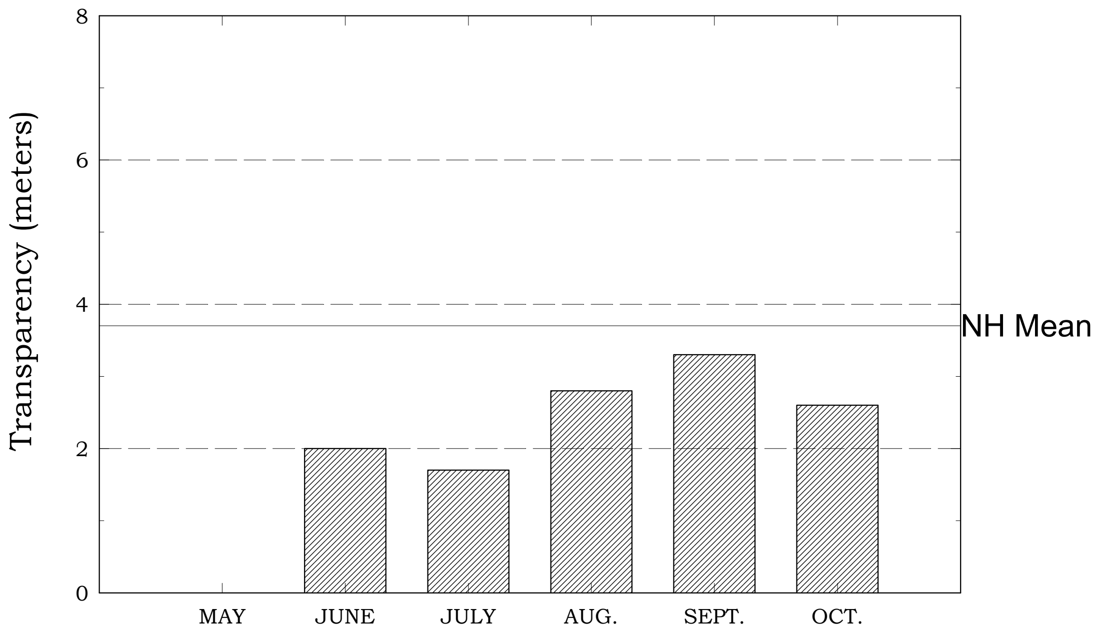
Figure 1. Monthly and Historical Chlorophyll-a Results



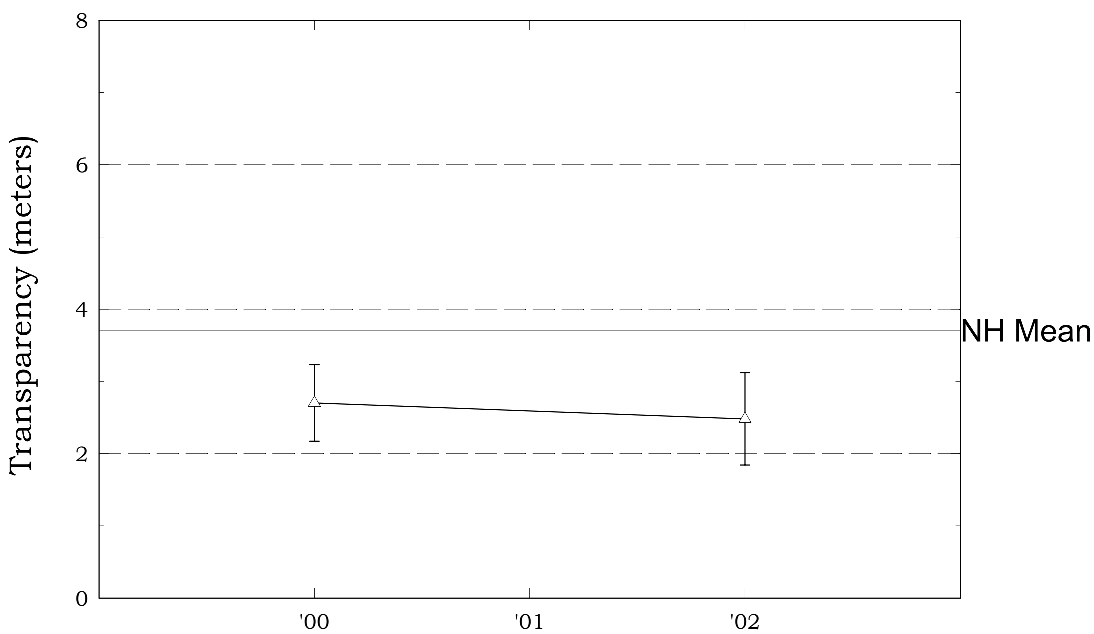


Mine Falls Pond, Nashua

Figure 2. Monthly and Historical Transparency Results



2002 Transparency Results



Historical Transparency Results

Mine Falls Pond, Nashua

Figure 3. Monthly and Historical Total Phosphorus Data.